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11 कि. वो. से 33 कि. वो. तक कार्यकारी वोल्टता के केबलों के लिए संक्रमण जोड़ — कार्यकारिता अपेक्षाएं और टाइप परीक्षण

Indian Standard

TRANSITION JOINTS OF CABLES FOR WORKING VOLTAGES FROM 11 kV UP TO AND INCLUDING 33 kV — PERFORMANCE REQUIREMENTS AND TYPE TESTS

UDC 621·315·687·1·027·6 : 620·16

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NEW DELHI 110002

May 1993 **Price Group 3**

Power Cables Sectional Committee, ET 09

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Power Cables Sectional Committee had been approved by the Electrotechnical Division Council.

Many methods are in vogue for making transition joints of cables using different materials and techniques. This standard does not refer to materials to be used or actual method of jointing. However, it is expected that materials to be used would be inert and capable of resisting degradation during the service life of the cable system.

The transition joints of cables are normally made at site. For practical reasons, this standard is confined to type tests only.

The cable transition joints should normally have same electrical and thermal characteristics as the cable for which these are intended. As such this standard is to be read in conjunction with the relevant cable specification. At present these specifications are IS 692 : 1973 'Specification for paper insulated lead sheathed cables for electricity supply', IS 1554 (Part 2) : 1981 'Specification for PVC insulated (heavy duty) electric cables: Part 2 For working voltages from 3·3 kV up to and including 11 kV (*first revision*)', IS 7098 (Part 2) : 1985 'Specification for crosslinked polyethylene insulated PVC sheathed cables : Part 2 For working voltage from 3·3 kV up to and including 33 kV (*first revision*)', IS 9968 (Part 2) : 1981 'Specification for elastomer-insulated cables: Part 2 For working voltages from 3·3 kV up to and including 11 kV'.

Should, however, any deviation exist between individual cable specification and this standard, the provisions of the latter shall apply.

Indian Standard

TRANSITION JOINTS OF CABLES FOR WORKING VOLTAGES FROM 11 kV UP TO AND INCLUDING 33 kV — PERFORMANCE REQUIREMENTS AND TYPE TESTS

1 SCOPE

1.1 This standard covers the performance requirements and type tests for transition joints between PILC cables and polymer insulated power cable for voltage grades from 11 kV up to and including 33 kV.

1.1.1 This standard is applicable for transition joints between screened polymeric cables and PILC cable.

2 REFERENCES

2.1 Following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
1885 (Part 32) : 1971	Electrotechnical vocabulary: Part 32 Cables, conductors and accessories for electricity supply
10810	Methods of test for cables:
(Part 5) : 1984	Conductor resistance test
(Part 45) : 1984	High voltages test
(Part 47) : 1984	Impulse test
(Part 48) : 1984	Dielectric power factor test

3 TERMINOLOGY

3.1 For the purpose of this standard, the definitions given in IS 1885 (Part 32) : 1971 and the following shall apply.

3.2 Type Test

Thess are the tests carried out to prove conformity with the standard. These are intended to prove the general qualities and design of a particular type of transition joint.

4 TEST SPECIMENS

4.1 The test specimen shall be made in the testing laboratory by using the polymeric insulation cable and PILC cable conforming to relevant Indian Standard, of the same nominal voltage and by using the materials prescribed and in accordance with the instructions of joint kit (system) supplied by the manufacturer. The accessories kit shall be of the same nominal voltage as the cable sample.

4.2 The test specimen shall be made of PILC cables having conductor cross section between 120 sq mm and 300 sq mm, joined to XLPE/elastomeric cables of one size lower cross section or to PVC cable of one size higher cross section.

4.3 The test specimen may consist of two transition joints in series.

4.4 The length of the test specimen between testing terminals shall be not less than 5 m. The length between the neck of the joint and the cable terminal shall be not less than 2 m and the distance between joints (if applicable) shall be not less than 3 m.

5 TYPE TESTS AND EVALUATION

5.1 Type tests and their sequence shall be as specified in Table 1.

5.2 If a transition joint does not pass particular test, the entire type tests shall be repeated on a freshly prepared test specimen.

5.3 If during testing, a cable damage occurs, it may be repaired. If repair is not possible, then the test shall be repeated on a new test specimen.

6 TEST PROCEDURE

6.1 Conductor Resistance Test

This test shall be done in accordance with IS 10810 (Part 5) : 1984.

6.2 Impact Test

The joint shall be placed on a hard base of concrete slab or floor as shown in Fig. 1. A wedge shaped mass of 4 kg having a 90° angle with a 2 mm radius impacting edge shall be dropped freely 6 times from a height of 2 m on the specimen in such a way that impacting edge is horizontal and at right angle to the axis of the joint. The drops shall be distributed over the length of the joint. There shall be no visible damage of the joint.

Table 1 Type Tests

(*Clause* 5.1)

Sl No.	Test Sequence	Parameter for Evaluation	Test Voltage Between Conductor and Screen in kV for Rated Voltage U_0/U in kV			Criteria of Evaluation
			6·35/11	12·7/22	19/3	
(1)	(2)	(3)	(4)			(5)
1	Conductor resistance test **(6.1)**	Conductor resistance				The resistance value shall be computed at 20°C and recorded
2	Impact test **(6.2)**					There shall be no visible damage
3	Dielectric power factor test as a function of voltage **(6.10)**					As per Table 3
4	ac voltage withstand test **(6.3)**	Duration : 1 minute	35	55	75	There shall be no breakdown
5	Impulse withstand test **(6.4)**		75	123	170	There shall be no breakdown and no flashover
6	ac voltage life test with cyclic current loading **(6.5)**	No. of cycles : 3		2·5 U_0		There shall be no breakdown
7	Dielectric power factor test as a function of voltage					Same as under Sl No. 3
8	ac voltage life test with cyclic current loading **(6.5)**	No. of cycles : 60		2·5 U_0		There shall be no breakdown
9	Thermal short circuit test **(6.6)**	Current as percent (Table 2)				There shall be no visible damage. The temperature of the conductor shall not exceed the maximum short circuit temperature as specified in Table 2
10	Conductor resistance test **(6.1)**	Conductor resistance				Conductor resistance variation shall not exceed 10 percent of that recorded under Sl No. 1
11	Water tightness test	No. of cycles : 60		2·5 U_0		There shall be no breakdown
12	Conductor resistance test **(6.1)**					Same as under Sl No. 9
13	Impulse withstand test **(6.4)**		75	125	170	There shall be no flashover and breakdown
14	dc voltage withstand test **(6.8)**	Duration of dc	45	96	144	There shall be no breakdown and flashover
15	Dynamic short circuit test **(6.9)**	Mechanical short circuit strength (kA)		40 kA		Test not applicable
				Above 40 kA		There shall be no visible damage
16	Impulse withstand test **(6.4)**		75	125	170	There shall be no breakdown and no flashover
17	dc voltage withstand test **(6.8)**	Duration of dc voltage 30 minutes	48	96	144	There shall be no breakdown and flashover

NOTE — Sl No. 16 and 17 are applicable only for transition joints for which dynamic short circuit test is required.

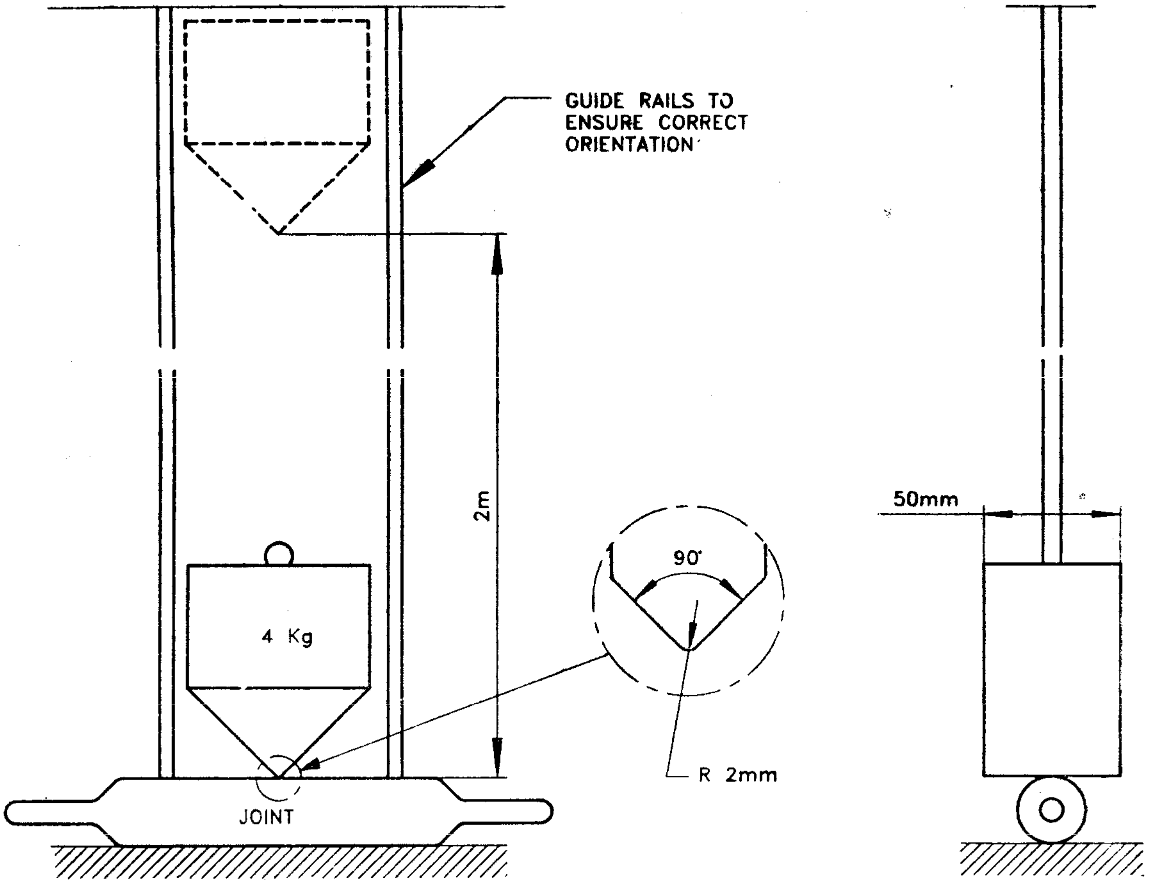

FIG. 1 IMPACT TEST APPARATUS

6.3 ac Voltage Withstand Test

This test shall be carried out in accordance with IS 10810 (Part 45) : 1984.

The high voltage source is connected to the conductor of the core under test. The conductors of cores not under test, screen and armour are connected to the earth terminal, depending on the mode of connection.

The voltage is to be raised sufficiently slowly to permit accurate reading of the measuring instruments but not so slowly as to cause unnecessary prolongation of the stress near the test voltage.

The test voltage is raised to the specified value and is maintained for one minute. After the specified time, the voltage is rapidly decreased but the voltage is not interrupted suddenly to avoid the possibility of switching transients which may affect the subsequent test results.

6.4 Impulse Withstand Test

This test shall be carried out in accordance with IS 10810 (Part 47) : 1984 but with the sample at room temperature. The test specimen shall withstand without breakdown, ten positive and ten negative impulses with 1·2/50 micro seconds wave.

6.5 ac Voltage Test with Cyclic Current Loading

The test specimen shall undergo specified number of cylces. Each cycle consists of a five hours heating period and three hours cooling period without current. The heating current depends on the size of the conductor of PILC cable, irrespective of the type of polymeric cable used for making the joint. The current should be adjusted so as to raise the conductor temperature 10°C higher than its normal working temperature for PILC cable as specified in IS 692 : 1973. The conductor shall attain the specified temperature within the first two hours of the heating period.

6.5.1 *Test Circuits of Heating Current*

The conductors may be connected in series and heated in single phase.

The conductors are heated in three phases.

The conductors may be heated in three separate heating circuits. The case of cables with magnetic reinforcement, these must be switched to a polyphase ac system with symmetrical phases.

6.6 Thermal Short Circuit Test

Before starting the short circuit test, the test specimen shall be heated by passing suitable current through the conductor so that the conductor of PILC cable attains the normal operating temperature as specified in IS 692 : 1973. Then the thermally effective short circuit current as given in Table 2 shall be passed through the conductor of the test specimen for a duration of one second. The values have been calculated according to the formula given in Annex A.

The voltage applied to the test circuit shall not be higher than that which is required for achieving the short circuit current.

6.7 Test for Water Tightness

This test is essentially the same as the ac voltage life test with cyclic current loading (**6.4**) with the joint immersed in water.

6.7.1 *Test Arrangement*

The joint shall be placed in a container filled with water in such a manner that the distance between the upper side of the cable, the neck of the joint and the water level is at least 250 mm. The joint may lie at the bottom of the container, this test shall be carried out at room temperature.

6.7.2 *Cutting of Sheath*

The outer sheath of the polymeric insulated cable shall be removed for a length of 50 mm, this being done at a distance of 50 mm from the neck of the joint.

6.8 dc Voltage Withstand Test

The conductor of the core under test shall be connected to the negative pole; and the core not under test and earth lead are connected to the positive pole of the dc power supply.

The voltage shall be raised sufficiently slowly to permit accurate reading of the measuring instruments but not ac slowly as to cause unnecessary prolongation of the stress near the test voltage.

The test voltage is raised to the specified value and maintained for 30 minutes. After the specified time, the voltage is gradually reduced to zero.

6.9 Dynamic Short Circuit Test

Before starting the test, the conductor of the test specimen shall be heated to its normal operating temperature by passing suitable current through the conductor. The peak current of 2·55 times the thermal short circuit current shall be established with oscillograph. The duration of the current should be selected in such a way that at least half cycle is achieved during the test. The voltage applied to the test circuit shall not be higher than that required to achieve the short circuit current.

Joint for the single core cables shall be tested by connecting the test specimen across two phases of the output of the test arrangement and those of three core cables across the three phases of the test arrangement.

The dynamic short circuit test shall be applicable for cable accessories of voltage range 11, 22 and 33 kV, for those sizes of conductor for which the dynamic short circuit strength is more than 40 kA.

6.10 Dielectric Power Factor Test (Applicable to Screened Cables Only)

This test shall be done in accordance with IS 10810 (Part 48) : 1984. Criteria for evaluation as a function of voltage shall be as given in Table 3.

Table 2 Thermally Effective Short Circuit Currents for Heating the Conductor to Short Circuit Temperature in One Second

(*Clause* 6.6)

Type of Cable	Normal Operating Temperature °C (*Max*)	Short Circuit Temperature °C (*Max*)	Thermally Effective Short Circuit Current (kA)					
			Copper Conductor			Aluminium Conductor		
mm			120 sq-mm	150 sq-mm	185 sq-mm	230 sq-mm	150 sq-mm	185 sq-mm
1. 11 kV (Screened) 19·78	70°C	160°C		13·8	17·25	21·27	9·10	11·40
2. 22 × 33 kV 11·35	65°C	120°C		11·13	13·91	17·16	7·30	9·20

Table 3 Criteria of Evaluation of Dielectric Power Factor Test as a Function of Voltage

(*Clause* 6.10)

Type of Test Specimen	Maximum tan at Uo	Maximum Increment tan Between 0·5 Uo and 2 Uo
1. Transition joint between XLPE insulated and PILC cables:		
a) for PILC cables with normal compound	0·008	0·002 4
b) for PILC cable with non-draining type compound	0·01	0·012
2. Transition joint between PVC insulated and PILC cables	0·1	0·006 5
3. Transition joint between elastomeric insulated and PILC cables:		
a) Butyl rubber	0·03	0·005 5
b) EPR	0·02	0·002 5

NOTE — For dielectric power factor test for belted PILC cables of 11 kV grade with non-draining compound following values are specified for:

a) *Max* tan at Uo	0·03
b) *Max* increment of tan between 0·5 Uo and 2 Uo	0·025

ANNEX A

(*Clause* 6.6)

CALCULATION OF SHORT CIRCUIT CURRENT

A-1 The short circuit current is given by the formula:

$$I^2 = \frac{K^2 S^2}{T} \text{ Log e } \frac{\theta_1 + \beta}{\theta_0 + \beta}$$

where

I = Short circuit current, amperes (rms over duration);

T = Duration of short circuit, second;

K = Constant for the material of the conductor;

S = Area of cross section of conductor, mm^2;

θ_1 = Final temperature of conductor;

θ_0 = Initial temperature of conductor; and

β = Reciprocal of the temperature coefficient of resistance of the conductor (per degree at 0°C).

A-2 The constants for the usual metals are given in Table 4, in which

$$K = \frac{Q_c (\beta + 20)}{\rho_{20}}$$

where

Q_c = Volume specific heat of the conductor at 20°C (J/°C mm^3)

ρ_{20} = resistivity of conductor material at 20°C (ohm mm)

Table 4 Constants for Short Circuit Calculation

(*Clause* A-2)

Material	K		°C	P20
Copper	226	234·5	$3{\cdot}45 \times 10^{-3}$	$17{\cdot}241 \times 10^{-6}$
Aluminium	148	228	$2{\cdot}5 \times 10^{-3}$	$28{\cdot}26 \times 10^{-6}$
Lead	42	230	$1{\cdot}45 \times 10^{-3}$	214×10^{-6}
Steel	78	202	$3{\cdot}8 \times 10^{-3}$	138×10^{-6}

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